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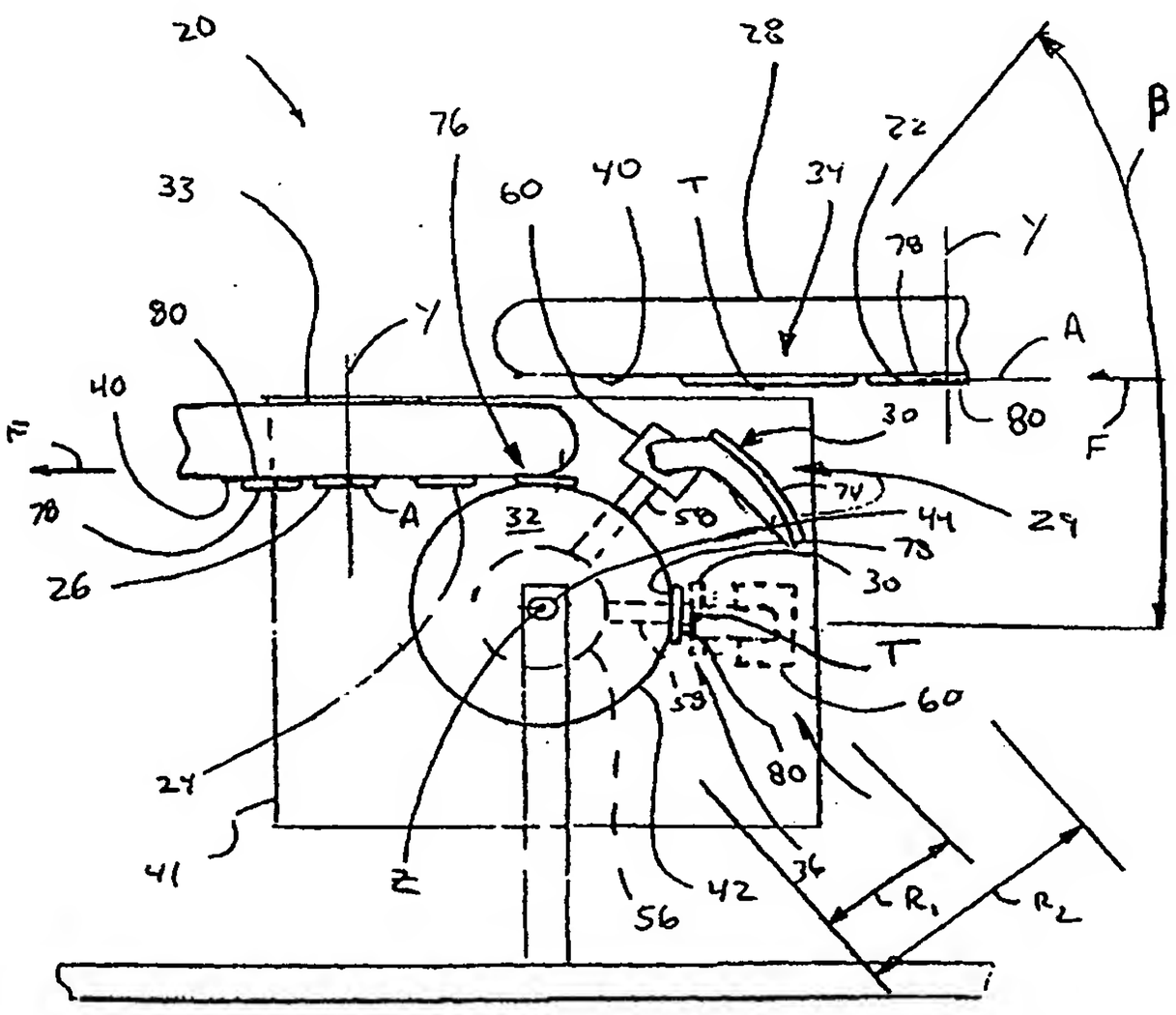
(54) Title: APPARATUSES AND METHODS FOR RE-ORIENTING AN ARTICLE

(57) Abstract

An apparatus for changing the orientation of an article is provided which comprises a first rotational axis (2), a first article location (34) whereat the article has a first article orientation, and a second article location (34) whereat the article has a second article orientation. A platform (30) is provided having a surface adapted to receive the article adjacent the first article location and to discharge the article at the second article location. The platform is arranged at a first radial distance from the first rotational axis at the first article location and at a second radial distance from the first rotational axis at the second article location. The platform is adapted to rotate about the first (Z) and second rotational axes (S2) to move from the first article location to the second article location, wherein the second rotational axis also rotates about the first rotational axis as the platform moves from the first article location to the second article location.



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APPARATUSES AND METHODS FOR RE-ORIENTING AN ARTICLE

FIELD OF THE INVENTION

This invention relates generally to the field of devices and methods for changing the orientation of an article, and, more particularly, to devices and methods which can selectively change the spacing or pitch, the yaw orientation, and/or the roll orientation of an article or series of articles.

BACKGROUND OF THE INVENTION

Various machines and methods for changing the orientation of articles are currently available. For example, U.S. Patent No. 4,483,351 to Seragnoli discloses a device for rotating cigarettes, such that two adjacent rows of cigarettes can be combined into a single row. A cradle engages the cigarettes of the second row and can purportedly rotate these cigarettes approximately 180 degrees to insert them into predetermined spaces between the cigarettes of the first row. The cradle is disposed between two rotating drums which transport the cigarettes such that the cradle can rotate between the first and second drum.

U.S. Patent No. 5,104,116 to Pohjola pertains to a device for receiving and rotating strips of material comprising a rotating drum having a plurality of rectangular surfaces for receiving articles. The articles are re-oriented by rotation of the drum and the surfaces such that the articles are be provided with a second angular orientation relative to the drum s rotational axis.

While the above-described devices may be suitable for the purposes for which they were designed, a need exists to provide improved apparatus and method for quickly and efficiently changing the orientation of articles so that they can be easily grouped and packaged for distribution. For example, there is a need for improved apparatuses and methods for efficiently changing the pitch (i.e., article spacing), roll

orientation (i.e., the orientation about a longitudinal axis of an article), and/or yaw orientation (i.e., the orientation about an axis transverse to the longitudinal axis of an article) of articles prior to packaging.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention, an apparatus for changing the orientation of an article is provided which comprises a first rotational axis, a first article location whereat the article has a first article orientation, and a second article location whereat the article has a second article orientation. A platform is provided having a surface adapted to receive the article adjacent the first article location and to discharge the article at the second article location. The platform is arranged at a first radial distance from the first rotational axis at the first article location and at a second radial distance from the first rotational axis at the second article location. The platform is adapted to rotate about the first and second rotational axes to move from the first article location to the second article location, wherein the second rotational axis also rotates about the first rotational axis as the platform moves from the first article location to the second article location.

In a preferred form, the apparatus further comprises a rotatable drum which is disposed adjacent the platform. The drum is adapted to rotate about the first rotational axis and has an outer surface adapted to receive the article adjacent the second article location from the platform. A gearbox interconnects the platform with a first shaft, the first shaft also being connected to and rotating with the drum. The gearbox also has a second shaft disposed about the second rotational axis which is adapted to rotate the platform. A frame supports the drum and has a race disposed thereon. A cam interconnected with the gearbox slidably engages the race and cooperates therewith to rotate the second shaft about the second rotational axis, thereby also rotating the platform.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the invention, it is believed the same will be better understood from the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a schematic side view of a preferred article transport system made in accordance with the present invention, wherein a rotational assembly is shown at a first article location and in dashed relief at a second article location;

Fig. 2 is a schematic top view of the article transport system of Fig. 1;

Fig. 3 is a schematic perspective view of the article transport system of Fig. 1, wherein the infeed and discharge conveyors have been removed for clarity;

Fig. 4 is a partial schematic top view of the article transport system of Fig. 3, wherein a portion of the gear box housing has been removed to illustrate certain structural details therein;

Fig. 5 is a schematic illustration of the article transport system of Fig.1, wherein certain structural details have been removed for clarity and certain dimensional and axial relationships are illustrated;

Figs. 6A to C are schematic perspective views of the article transport system of Fig. 1, wherein the rotational assembly is shown in multiple positions between the first article location and the second article location;

Fig. 7 is a schematic perspective view of the article transport system of Fig.1, wherein certain structural details have been removed and certain dimensional and axial relationships are illustrated for describing a preferred process for designing an article transport system made in accordance with the present invention;

Fig. 8 is a schematic perspective view of another article transport system made in accordance with the present invention having a hub and a plurality of radially extending arms;

Fig. 9 is a schematic top view of the article transport system of Fig. 8;

Fig. 10 is a schematic elevation view of the article transport system of Fig. 8; and

Fig. 11 is a schematic perspective view of the article transport system of Fig. 8, wherein certain structural details have been removed and certain dimensional and axial relationships are illustrated for describing another preferred process for designing an article transport system made in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings, wherein like numerals indicate the same elements throughout the views. A particularly preferred embodiment of the present invention is illustrated in Fig. 1 in the form of an article transport system 20 which can selectively change the pitch, roll orientation, and/or yaw orientation of an article 22 which is transported by the article transport system 20. As used herein, the word "pitch" is intended to refer to the distance between two predetermined points (e.g., the geometric center or center of mass) of, for example, adjacent articles 24 and 26, while the phrase "roll orientation" is intended to refer to the rotational orientation or position of an article 22 about a first axis of this article (e.g., longitudinal axis A). The phrase "yaw orientation", as used herein, is intended to refer to the rotational orientation or position of an article 22 with respect to a second axis (e.g., axis Y) of this article transverse or substantially perpendicular to the first axis A, as shown by way of example in Fig.1. More preferably, this second axis Y is also

substantially perpendicular to a vector F which represents the direction of travel of the article 22 at first and second article locations 34 and 36. Thus, as will be apparent, the article 22 preferably has the same direction of travel at the first and second article locations but different orientations thereat.

A change in the roll orientation or the yaw orientation of an article 22 will be referred to herein with respect to an actual or effective rotation of the article about the axis associated with the orientation. An effective rotation has the same result as if the article had been rotated about the axis such that the article s orientation is changed, although the article is not physically rotated about this axis. Thus, a change in the roll orientation of an article 22 would have associated therewith an actual or effective rotation of the article 22 about the longitudinal axis A. Likewise, a change in the yaw orientation of an article 22 would have associated therewith an actual or effective rotation of the article 22 about the axis Y. In its most preferred embodiment, the present invention can provide selected changes in the pitch, roll orientation, and/or yaw orientation of one or more articles 22. The term "re-orient" will be used generically herein to refer to changes in the pitch, roll orientation, and/or yaw orientation of one or more articles 22.

Transport systems made in accordance with the present invention can be particularly suited for changing the pitch, roll orientation, and/or the yaw orientation of elongate articles, such as sanitary napkins and the like, which can weigh between about 1 ounce (28 gm) and about 5 ounces (141 gm) and have a length of about 10 inches (25 cm), a width of about 3 inches (6 cm), and a thickness of about 0.25 inches (0.6 cm). While the present invention is particularly suited for use with thin, lightweight and elongate articles such as these, it is contemplated that the present invention can also be adapted to change the pitch, roll orientation, and/or yaw orientation of other articles of varying shapes,

masses and compositions. For example, the present invention can be used to re-orient symmetrical, asymmetrical, cylindrical, and polyhedral shaped articles. In addition, the present invention can be used to re-orient articles formed from a variety of materials including, but not limited to, paper, fabric, plastic, metal, and articles formed from combinations of these and similar materials.

As shown in Fig. 1, the transport system 20 preferably comprises an infeed conveyor 28 for transporting the articles 22 in the direction of the vector F to at least one rotational assembly 29 having a platform 30. A drum 32, which rotates about a drum axis Z, receives the articles from the platform 30. A discharge conveyor 33, in turn, receives and transports the articles away from the rotating drum 32 in the same direction as vector F. As will be understood more fully hereafter, the platform 30 receives the articles at the first article location 34 adjacent the infeed conveyor 28 and discharges or feeds the articles 22 to the drum 32 at a second article location 36, the rotational assembly 29 being shown in dashed line in Fig. 1 at this second article location.

The discharge conveyor 33 preferably subsequently removes and/or otherwise receives the articles 22 from the drum 32 and transports them to another location for further processing if desired (e.g., further manufacturing procedures or packaging of the articles, etc.). The article transport system 20 is adapted to receive an article 22 at the first article location 34 in a first orientation with respect to the vector F and discharge this article at the discharge conveyor 33 with a second orientation with respect to the vector F. More particularly, as an article 22 is transported between the infeed conveyor 28 and the discharge conveyor 33 via the combination of the rotational assembly 29 and the drum 32, the pitch, roll orientation, and/or the yaw orientation of the articles 22 can be changed such that the articles 22 disposed on the discharge conveyor 33 have a predetermined different spacing (i.e.,

pitch) and orientation (i.e., roll and/or yaw) from the articles 22 disposed on the infeed conveyor 28, as discussed more fully hereafter.

As an example of an arrangement where elongate sanitary napkin products or the like are processed, an article transport system made in accordance with the present invention might change the pitch of the articles 22 from between about 8 inches per article and about 14 inches per article (35 cm/article) on the infeed conveyor 28 to between about 4 inches per article (10 cm/article) and about 7 inches per article (18 cm/article) on the discharge conveyor 32, while the roll orientation of these articles can be changed by about 180 degrees (i.e., the articles are effectively rotated about 180 degrees about their longitudinal axes A between the infeed conveyor 28 and the discharge conveyor 33). In addition, the present invention can change the yaw orientation of the articles about 90 degrees (e.g., effectively rotate the articles about 90 degrees about their axes Y) as the articles 22 are transported between the infeed conveyor 28 and the drum 32 by the platform 30. The above-described re-orienting of the articles 22 is especially useful in the manufacturing and packaging arts where it is often necessary to change the orientation of articles after manufacture in preparation for packaging.

Referring to Fig. 1 in more detail, for lightweight articles, the infeed conveyor 28 and the discharge conveyor 33 might preferably be provided in the form of vacuum conveyors capable of providing a negative pressure or suction which is sufficient to hold the articles 22 securely in contact with the conveyor transport surface 40 against the force of gravity. As can be seen, the conveyors 28 and 33 are preferably arranged in an inverted manner so that the heavier drum 32 and rotational assemblies 29 can be supported by a frame 41 which rests upon the floor or other solid surface, rather than suspended above the conveyors, as would be the case with a conventional conveyor system

whose conveyor transport surface was right side up. While it is preferred that the infeed conveyor 28 and the discharge conveyor 33 be provided in the form of vacuum conveyors having an inverted conveyor transport surface, it is contemplated that these conveyors can also be provided in the form of a conventional belted conveyor, wherein the articles 22 are held against the conveyor transport surface by gravity and the drum 32 and platform 30 are suspended above the conveyor surface. Similarly, where the articles include metallic components, a magnetic bed might be used with the conveyor to hold the articles as appropriate.

As shown in Figs. 1 and 2, the infeed conveyor 28 and the discharge conveyor 33 are preferably offset both radially (i.e., one is above the other as shown in Fig. 1) and axially (i.e., one is behind the other as shown in Fig. 2) relative to the drum axis Z and are substantially parallel to each other in a direction transverse to the drum axis Z such that articles transported on both conveyors have substantially the same direction of travel as shown by the vector F. This radial and axial offset of the conveyors provides clearance for rotation of the platform 30 about both the drum axis Z and an axis S_2', as described more fully hereafter.

As seen best in Figs. 1-4, the drum 32 is fixedly interconnected and coaxial with shafts 44 along drum axis Z, about which the drum and rods rotate. The drum 32 is illustrated with a radius R_1 which extends from the drum axis Z to an outer surface 42 of the drum 32, and a length L between a proximal end 46 and a distal end 48 of the drum 32. Thus, rotation of the shafts 44 in turn rotates the drum 32 such that both will rotate at the same angular velocity. Alternatively, the shafts 44 can be replaced by a single axle extending through the drum 32. While not illustrated, either rod 44 can be rotated by means commonly employed in the art, such as, for example, by an electric motor connected either directly to one of the shafts 44 or indirectly by

chains, belts, or the like. As best seen in Figs. 3 and 4, in a preferred implementation, the shafts 44 are supported by a stationery frame 41 having an eccentric race 52 adjacent the distal end 48 of the drum 32 which cooperates with the rotational assembly 29 to change the pitch and/or yaw orientation of an article 22 as it is moved between the infeed conveyor 28 and the drum 32 by the rotational assembly 29.

The shafts 44 adjacent the distal end 48 of the drum 38 can be fixedly connected to a disk 56, or similar structure, which supports the rotational assembly 29 and is offset a predetermined distance from the distal end 48 of the drum 32. As seen in Fig. 4, the rotational assembly 29 preferably comprises an arm 58, a gear box 60, and the platform 30. The arm 58 interconnects the disk 56 and gear box 60 such that both will rotate at the same angular velocity about the drum axis Z. Thus, rotation of the shafts 44 will rotate the drum 32, the disk 56, and the rotational assembly 29 at the same angular velocity. Providing a drum and platform which rotate at the same angular velocity about the drum axis Z can facilitate transfer of an article 22 between the platform 30 and the drum 32 at the second article location 36.

While the article transport system 20 is illustrated as comprising one arm 58 and its associated rotational assembly 29 for the purpose of clarity, as noted above, the article transport system 20 can be provided with a plurality of arms 58 and rotational assemblies 29 which are equally spaced about the disk 56. More preferably, the article transport system 20 comprises between about 6 and about 10 rotational assemblies 29. As the number of rotational assemblies 29 increases, the angular velocity of the drum 32 and platform 30 can be decreased for a constant article feed rate (i.e., the rate at which articles are fed to the first article location 34). For example, an article transport system having 6 rotational assemblies 29 can operate at an angular velocity of about 166 rpm at an article feed rate of about 1,000 articles per minute, while

the same article transport system at the same article feed rate can operate at an angular velocity of about 100 rpm with 10 rotational assemblies 29, the increased number of assemblies permitting a reduced angular velocity while still accommodating the same article feed rate. Lower angular velocities are generally preferred as the weight of the articles 22 increases so as to minimize the centrifugal forces imparted upon the articles and rotational assemblies.

The gear box 60 is shown in Fig. 4 as comprising a housing 61 rotatably supporting a first shaft 62 which is connected to a cam 64 preferably engaging and at least partially disposed in the eccentric race 52. A first beveled gear 66 is connected to the first shaft 62 opposite the cam 64 and engages a second beveled gear 68 attached to a second shaft 70. The first beveled gear 66 and the second beveled gear 68 are preferably adapted to provide a ratio of rotation between the first shaft 62 and the second shaft 70 of about 1 to about 3. Thus, the second shaft 70 preferably rotates about three degrees for one degree of rotation of the first shaft 62, the rotation of the first shaft 62 being governed by the cam 64 and the eccentric race 52. The eccentric race 52 is preferably adapted to rotate the cam 64 which, in turn, rotates the first shaft 62 an angle of between about 68 degrees and about 74 degrees in a counter-clockwise direction (when viewed in the direction of arrow 71) between the first article location 34 and the second article location 36.

In the preferred arrangement for lightweight articles, the eccentric race 52 and cam 64 are adapted to also accomplish the above-described rotation of the first shaft 62 between the article locations within an angle β (Fig. 1) of about 110 degrees about the drum axis Z, wherein the angle β is the angle between point E, shown by way of example in Fig. 4, at the first article location 34 and the same point E at the second article location 36, point E representing the point along an axis S_2' about which the platform 30 rotates, as discussed more fully hereafter. In other

words, the rotational assembly 29 preferably rotates about 110 degrees about the drum axis Z between the first article location 34 and the second article location 36, with the cam 64 rotating the first shaft 62 between about 68 degrees and 74 degrees also within this 110 degree rotation. Based upon the exemplary one to three rotational ratio between the first shaft 62 and the second shaft 70, the second shaft 70 rotates about the axis S_2 between about 204 degrees and 222 degrees (angle Δ in Fig. 5) in a clockwise direction (when viewed in the direction of arrow 73 of Fig. 4) between the first article location 34 and the second article location 36.

As the rotational assembly 29 rotates through the second article location 36 and returns to the first article location 34 (i.e., rotates one full revolution about the drum axis Z), the eccentric race 52 and cam 64 are preferably adapted to rotate the first shaft 62 in a clockwise direction the same amount as it was rotated in a counter-clockwise direction between the first article location 34 and the second article location 36, thereby returning the platform 30 to its initial position and orientation at the first article location 34. Thus, in this exemplary illustration, the first shaft 62 preferably oscillates counter-clockwise and then clockwise between about 68 degrees and about 74 degrees for each full revolution of the rotational assembly 29 about the drum axis Z, this oscillation being controlled by the cam 64 and eccentric race 52.

As shown in Fig. 4, an extension 72 is connected to the second shaft 70 and the platform 30 such that rotation of the second shaft 70 also rotates the platform 30. For ease of discussion, as illustrated in the schematic of Fig. 5, the platform 30 can be approximated as rotating the angle Δ about the theoretical point E which is disposed on the axis S_2 the second shaft 70, although point E does not necessarily form part of the rotational assembly 29 as shown in Fig. 4 and point E would, during operation, also rotate about the drum axis Z. Thus, it will be apparent

that as the rotational assembly 29 rotates one full revolution about the drum axis Z, the platform 30, in addition to also rotating one full revolution about the drum axis Z, will also rotationally oscillate about the axis S_2 of the second shaft 70 according to the rotational oscillations of the first shaft 62. The platform 30 preferably comprises an arcuate receiving surface 74 (best seen in Fig. 3) which is adapted to receive an article 22 from the infeed conveyor 28 at the first article location 34, the arcuate surface facilitating the interaction between the platform 30 and the article 22 as the platform 30 approaches the first article location 34. This transfer can be accomplished by reducing or reversing the negative pressure or suction applied by the infeed conveyor 28 to the article 22 so that the article can easily translate or move between the infeed conveyor 28 and the platform 30. The receiving surface 74 can also be provided with the capability of applying a negative pressure or suction to an article 22 so as to retain the article 22 against the receiving surface 74 of the platform 30 between the first article location 34 and the second article location 36. The amount of negative pressure applied by the platform 30 on an article 22 will be dependent upon the weight of the article 22 and the angular velocities of the platform 30 about the drum axis Z and the axis S_2 of the second shaft 70.

The first shaft 62 and the second shaft 70 preferably have axes of rotation S_1 and S_2, respectively. Fig. 5 illustrates the movement of a platform 30 with respect to the drum 32, wherein the platform 30 is shown rotated about the axis of rotation S_2 of the second shaft 70 while the rotational assembly 29 is held fixed, for clarity, at the first article location 34 (i.e., angle β of Fig. 1 is zero). As shown, the axis of rotation S_2 of the second shaft 70 has an ascendency angle ψ and an offset angle θ associated therewith when the rotational assembly 29 is at this first article location 34. More particularly, the rotational axis S_2 of the second shaft 70 can be described as passing through a point P located in

a plane Q when the platform 30 is at the first article location 34, where the plane Q is coplanar with the drum axis Z and parallel to the vector F such that the plane Q is also substantially perpendicular to the second axis (i.e., axis Y) of the article 22 at the first article location 34. The ascendancy angle ψ refers to the angle between the rotational axis S_2 and its projection in the plane Q, while the offset angle θ refers to the angle between the projection of the vector F in the plane Q and the projection of the axis S_2 in the plane Q. Most preferably, the offset angle θ is about 45 degrees and the ascendency angle ψ is between about 12 degrees and about 20 degrees. As will be more fully understood hereafter, the values for the ascendency angle ψ and the offset angle θ can be varied based upon the desired change in article pitch and yaw orientation between the first and second article locations.

The operation of a preferred exemplary article transport system 20 will now be described. Accordingly, an exemplary rotation of the rotational assembly 29 and its associated platform 30 is shown in Figs. 6A to C between the first article location 34 and the second article location 36, wherein the platform 30 has rotated an angle Δ about the axis S_2, as previously described, and has rotated an angle β about the drum axis Z. For ease of discussion, the receiving surface 74 of the platform 30 has a platform point T disposed thereon which is located at a radius R_2 from the drum axis Z, as best seen in Fig. 6A, at the first article location 34. In accordance with one aspect of the present invention, the platform point T will move from radius R_2 to radius R_1 (i.e., adjacent the outer surface 42 of the drum 32, as shown in Fig. 6C) as the platform 30 rotates (about axes S_2 and Z) from the first article location 34 to the second article location 36, thereby changing the pitch of the articles 22 according to the ratio of the values of these radii. More particularly, the radius R_2 is chosen based upon the pitch of the articles on the infeed conveyor 28 and the number of platforms 30 while the

radius R_1 is selected based upon the new desired pitch of the articles on the discharge conveyor 33. For example, if the desired pitch of the articles 22 on the infeed conveyor 28 is 14 inches per article (35 cm/article) and the desired pitch of these articles 22 on the drum 32 is 7 inches per article (18 cm/article), which is also the pitch of the articles 22 on the discharge conveyor 33, the ratio of radius R_2 to radius R_1 would be about 2 to 1 to achieve this change in article pitch. Thus, the radius R_1 would be selected as one half of the radius R_2 so that movement of the platform 30 inwardly toward the drum axis Z as the platform 30 rotates between the first article location 34 and the second article location 36 would achieve the desired 2 to 1 change in pitch.

In accordance with another aspect of the present invention, the roll orientation of the articles 22 can be changed up to about 180 degrees between the first article location 34 and a third article location 76 (shown in Fig. 1) adjacent the discharge conveyor 32, the third article location 76 preferably being the location where the articles 22 are transferred between the drum 38 and the discharge conveyor 32. For example, as shown in Fig. 1, the articles 22 are disposed on the infeed conveyor 28 with a first side 78 adjacent the conveyor transport surface 40. However, after transfer to the discharge conveyor 32, a second side 80 of the articles 22 are disposed adjacent the conveyor transport surface 40 of the discharge conveyor 32, thereby resulting in an effective rotation of about 180 degrees of the articles 22 about axis A between the infeed conveyor 28 and the discharge conveyor 33. While the articles 22 are not actually rotated about their axes A, it will be apparent that the combination of transfers between the infeed conveyor 28 and the platform 30, the platform 30 and the drum 32, and the drum 32 and the discharge conveyor 33 results in an effective rotation of an article 22 about its axis A.

As set forth above, in accordance with still another aspect of the present invention, the article transport system 20 can also change the yaw orientation of the articles 22 between the first article location 34 and the second /third article locations. The orientation of the axis S_2 of the second shaft 70 with respect to the plane Q (previously discussed with respect to Fig. 5) can result in the article 22 effectively rotating about its axis Y such that the yaw orientation between the first article location 34 and the second article location 36 is changed about 90 degrees, as shown in Figs. 1 and 2. While the article 22 does not actually rotate about its Y axis, the rotation of the platform 30 about the point E results in an effective rotation about this axis.

A preferred process for designing an article transport system made in accordance with the present invention will now be described with respect to Figs. 5 and 7. This process can be implemented using a computer aided design (CAD) computer program, if desired. The radius R_2 is first determined based upon the pitch of the articles on the infeed conveyor 28 and the number of rotational assemblies 29, the number of rotational assembles and radius R_2 defining an arc length between rotational assemblies which corresponds to the pitch of the articles 22 on the infeed conveyor 28. The radius R_1 is next selected based upon the desired change in article pitch between the infeed conveyor 28 and the discharge conveyor 33, the ratio of the radii determining the change in pitch. Having determined the values of R_1 and R_2, the location of point T at the first article location 34 will be known. An angle α is selected based upon the length to width ratio of the article 22, wherein increasing the angle α allows greater axial separation along the direction drum axis Z between the first article position 34 and the second article position 36 so that the infeed conveyor 28 and the discharge conveyor 33 can be appropriately spaced apart, as shown in Fig. 2.

As shown in Fig. 7, the values of R_1 and R_2, and α thereby define a location 82 of the platform 30 if the platform is rotated about the axis S_2 of the second shaft 70 while the rotational assembly 29 is maintained at the first article location 34, the location 82 being a first approximation for the second article location 36. The orientation of the axis S_2 of the second shaft 70 (i.e., the values of the ascendency angle ψ and the offset angle θ for the axis S_2) are next determined by first locating a plane M, wherein the projections of the platform 30 at the first article location 34 and the location 82 have about the same size and about the same shape (although not necessarily the same orientation) in the plane M. After locating the plane M according to the above-described criteria, the location 82 of the platform 30 is adjusted by moving the platform 30 in a direction parallel to the drum axis Z until a location 83 is found where corresponding points defining the platform 30 at the first article location 34 are about the same distance G measured normally to the plane M as this new location 83, the location 83 representing the axial location along the drum axis Z of the second article location 36.

When the location 83 along the drum is found where corresponding points of the platform 30 have the same normal distance G to the plane M between the first article location 34 and the location 83, the surface of the platform 30 will be disposed adjacent the outer surface 42 of the drum 32 at this location 83 so that an article can be easily transferred therebetween. For example, the platform 30 of Fig. 7 has an exemplary point U which is a normal distance G from the plane M at the first and a second article locations 34 and 36 but a greater normal distance I at the second location 82 (which was the first guess for the second article location 36). Movement of the platform 30 parallel to the drum axis Z will have a component of movement toward the plane M such that this movement will reduce the value of the normal distance I for the point U until the location 83 is reached.

After determining the location 83, the orientation of the axis S_2 of the second shaft 70 which will rotate the platform 30 between the first article location 34 and the second article location 36 can be determined. Preferably, the axis S_2 is defined by a line which is normal to the plane M and passes through the point E, point E being a distance D and distance S from the platform point T, as shown in Fig. 7. In other words, the platform point T rotates about the point E, as previously described. The values of θ and ψ can be determined as shown in Fig. 5 while the values of S and D can be determined from the following relationships:

$$D = \frac{R_1 - (R_2 * (\cos \hat{A})}{(\cos \alpha)+1}$$

$$S = (\sin \alpha)\ (D+R_2)$$

Having determined the values of S, D, ψ, and θ, the structure of the arm 56, gear box 60, and extension 72 can be selected to accommodate these geometric relationships, as desired. The second article location 36 can next be determined based upon the location 83 and the angle β, the location 83 defining the axial position along the drum axis Z of the second article location 36 and the angle β defining the amount of angular rotation about the drum axis Z between these first and second article locations 34 and 36. The configuration of the eccentric race 52 and cam 64 can next be selected so as to provide the desired amount of angular rotation Δ about the axis S_2 between the first article position 34 and the second article position 36.

In a preferred embodiment for sanitary napkins or articles of similar handling characteristics, an article transport system made in accordance with the present invention could have the structural characteristics set forth in the table below, this embodiment being capable of decreasing the pitch of an article by one half, changing the roll orientation of an article by about 180 degrees, and changing the yaw

orientation of an article by about 90 degrees between a first article location and a second article location.

Parameter	**Value**
S	4.5 to 5.5 inches (11.4 cm to 14 cm)
D	2 to 3 inches (5 cm to 7.6 cm)
Number of rotational assemblies	6 to 10
ψ	12° to 20°
θ	45°
β	110°
Δ	204° to 222°
α	35° to 45°
R_1	5 to 8 inches (12.7 cm to 20.3 cm)
R_2	8.5 to 16 inches (12.6 cm to 40.6 cm)

Another embodiment of the present invention is illustrated in Figs. 8 to 11 as article transport system 120 which is particularly adapted to change the roll and yaw orientations of an article 122 between a first article location 134 adjacent an infeed conveyor 128 and a second article location 136 adjacent a discharge conveyor 133. The infeed conveyor 128 and the discharge conveyor 133 are preferably parallel to each other such that the articles 122 transported thereon have the same vector F (i.e., direction) of travel. The infeed conveyer 128 and discharge conveyor 133 are offset distances B, C, and H in three orthogonal directions, as best seen in Figs. 9 and 10.

As best seen in Figs. 8 to 10, the article transport system 120 comprises a plurality of platforms 130 (12 shown by way of example in Fig. 8) each of which are connected to a hub 90 by an arm 92. The article transport system rotates about a hub axis S_2' which passes through the center of the hub 90. Each of the arms 92 extend a radial

distance J from the axis S_2' to the center of each platform 130. The arms 92, platforms 130 and hub 90 are fixedly interconnected so that rotation of the hub 90 about the hub axis S_2' will similarly rotate the arms 92 and platforms 130. Each of the platforms 130 is preferably substantially U shaped and adapted to receive the rectangularly shaped article 122 at the first article location 134 in a first orientation with respect to the vector F and discharge this article at the second article location 136 with a second orientation with respect to the vector F'.

Each article 122 has a first axis A' and a second axis Y' substantially perpendicular to the first axis A', as shown by way of example in Fig. 8. As discussed more fully hereafter, the article transport system 120 can change the roll and yaw orientations of an article 122 about its A' and Y' axes, respectively, by about 90 degrees between the first article location 134 and the second article location 136 with only a single rotation Δ of the article transport system 120 about the axis S_2'.

The orientation of the axis S_2', with respect to the vector F', provides an article transport system 120 made in accordance with the present invention with the ability to accomplish the above-described re-orientation of an article 122 with a single rotation about the axis S_2' without an additional and separate rotation of a platform 130 about another axis, such as previously described with respect to article transport system 20. The axis S_2' has an ascendency angle ψ' and offset angle θ' associated therewith. The ascendency angle ψ' is the angle between the axis S_2' and the projection of that axis a plane Q', the plane Q being substantially parallel to both the vector F' and the axis Y' and located below the infeed and discharge conveyors, as shown in Fig. 8, while the offset angle θ' is the angle between the projection of the axis S_2' in the plane Q' and the projection of the vector F' of the infeed conveyor 128 in the plane Q'. In a preferred embodiment, the article transport

system 120 could have the structural characteristics set forth in the table below, this embodiment being capable of changing the roll and yaw orientations of an article 122 by about 90 degrees between the first article location 134 and the second article location 136.

Parameter	**Value**
θ'	About 45 degrees
ψ'	Between about 30 degrees and about 40 degrees
Δ'	About 120 degrees
Distance J	Between about 15 inches and about 20 inches (38.1 cm to 50.8 cm)
Distance B	Between about 20 inches and about 28 inches (50.8 cm to 71 cm)
Distance C	Between about 8 inches and about 11 inches (20.3 cm to 27.9 cm)
Distance H	Between about 12 inches and about 17 inches (30.5 cm to 43.2 cm)
Number of platforms	12

In accordance with another aspect of the present invention, a preferred process for designing the article transport system 120 will now be described in combination with Fig. 11. The desired orientations of an article 122 at the first and second article locations are first superimposed upon each other so that the geometric centers K of the article orientations coincide, as generally shown at 94. A plane M' is located, wherein the projection of the article orientations in the plane M' have about the same size and shape, as generally shown at 96. The axis

S_2' is then the axis which is completely perpendicular to the plane M' at a point P' and which passes through the superimposed geometric centers K of the article orientations at 94. Having determined the orientation of the rotational axis S_2', the values for the ascendency angle ψ' and offset angle θ' associated with the rotational axis S_2' can readily be determined with respect to the plane Q.

The first and second article locations 134 and 136 are next determined by measuring the an Δ between corresponding points U of the article projections in plane M' at 96 (the article projections also being shown as separated in the plane M' for purposes of clarity). The article projections in plane M' are then moved out along vectors L which lie in the plane M' and which pass through the point P' and the geometric centers K of the article projections in the plane M'. The magnitude and direction of the vectors L can be chosen based upon the desired placement (e.g., to obtain the offset distances B, C and H) of the infeed and discharge conveyors 128 and 133, so long as the vectors L are separated by the angle Δ'. The new separated locations of the article projections in plane M' represent the projections thereat of the first and second article locations 134 and 136.

Having located the rotational axis S_2', the offset distances B, C, and H, and the length J of the radial arms, the structural features of the hub and arms can be chosen to accommodate these geometrical relationships. In addition, the shape and orientation of the platforms 130 can be selected so that the platforms are adapted to receive an article 122 at the first article location 134 in the first article orientation and to discharge the article at the second article location 136 in the predetermined second article orientation.

Having shown and described the preferred embodiments of the present invention, further adaptions of the article transport systems described herein can be accomplished by appropriate modification by

one of ordinary skill in the art without departing from the scope of the present invention. Several of such potential modifications have been mentioned, and others will be apparent to those skilled in the art. For example, the article transport systems of the present invention can be operated in a reverse direction from that discussed herein so that the articles arrive in the exemplary orientation shown on the discharge conveyor of Fig. 2 and exit the article transport system in the exemplary orientation shown on the infeed conveyor of the same Figure 2. Similarly, the angles, sizes, number of platforms, infeed and discharge devices, and other structural and functional characteristics of the exemplary embodiments shown and described can be adapted to a wide variety of article handling applications by appropriate adjustments and modifications. The particular embodiments shown and described herein are intended only as preferred exemplary arrangements of the various structures and functions of the present invention. Accordingly, the scope of the present invention should be considered in terms of the following claims and is understood not be limited to the details of structure and operation shown and described in the specification and drawings.

What is claimed is:

1. An apparatus for changing the orientation of an article, comprising:

a first rotational axis;

a second rotational axis;

a first article location whereat the article has a first article orientation;

a second article location whereat the article has a second article orientation distinct from said first article orientation;

a platform having a surface adapted to receive article adjacent said first article location and to discharge article at said second article location, said platform being arranged at a first radial distance from said first rotational axis at said first article location and at a second radial distance from said first rotational axis at said second article location, said second radial distance being distinct from said first radial distance;

said platform adapted to rotate about said first and second rotational axes to move from said first article location to said second article location; and

wherein said second rotational axis rotates about said first rotational axis as said platform moves from said first article location to said second article location.

2. The apparatus of claim 1, wherein said platform is adapted to rotate about 360 degrees about said first rotational axis.

3. The apparatus of claim 1, wherein said first and second article orientations comprise a yaw orientation, said yaw orientation of said second article orientation being rotated about 90 from degrees from said yaw orientation of said first article orientation.

4. The apparatus of claim 1, further comprising a drum disposed located adjacent said platform and adapted to rotate about said first rotational axis and having an outer surface adapted to receive the article adjacent said second article location from said platform.

5. The apparatus of claim 4, further comprising a plurality of platforms.

6. The apparatus of claim 5, further comprising an infeed conveyor for transporting a plurality of the articles to said plurality of platforms, each one of said plurality of the articles having a first pitch associated therewith, each one of said plurality of the articles having a second pitch associated therewith after transfer to said drum.

7. The apparatus of claim 4, further comprising a gearbox which interconnects said platform with a first shaft connected to said drum, said gearbox having a second shaft disposed about said second rotational axis and adapted to rotate said platform.

8. The apparatus of claim 7, further comprising a frame for supporting said drum and having a race disposed thereon, said gearbox further comprising a cam slidably engaging said race and cooperating with said race to rotate said second shaft about said second rotational axis.

9. The apparatus of claim 7, wherein said rotation of said second shaft is between about 204 degrees and about 222 degrees between the first article location and the second article location.

10. The apparatus of claim 9, wherein said rotation of said platform about said first rotational axis is about 110 degrees between said first article location and said second article location.

11. The apparatus of claim 4, further comprising a discharge conveyor disposed adjacent said drum for receiving the article from said drum, the article having a third article orientation on said discharge conveyor, said first and third article orientations further each comprise a roll orientation, said roll orientation of said third article orientation being rotated about 180 degrees from said roll orientation of said first article orientation.

12. The apparatus of claim 7, wherein said gearbox further comprises a third shaft operatively interconnecting said cam and second shaft.

13. The apparatus of claim 7, further comprising an extension interconnecting said second shaft and said platform.

14. A method for changing the orientation of articles, comprising the steps of:

providing an apparatus having a first rotational axis, a second rotational axis, a first article location whereat the article has a first article orientation, a second article location whereat the article has a second article orientation distinct from said first article orientation, a platform for receiving the article adjacent said first article location and for discharging said article adjacent said second article location, said platform being a first radial distance from said first rotational axis at said first article location and said platform being a second radial distance from said first rotational axis at said second article location, said second radial distance being distinct from said first radial distance;

rotating said platform and said second rotational axis about said first rotational axis between said first article location and said second article location; and
rotating said platform about said second rotational axis between said first article location and said second article location.

15. The method of claim 14, further comprising the steps of providing a drum disposed adjacent said platform, transferring said article from said platform to said drum at said second article location, and rotating said drum about said first rotational axis.

16. The method of claim 15, further comprising the steps of providing a plurality of articles, each one of said plurality of articles having a pitch; changing said pitch of said articles between said first article location and said second article location.

17. The method of claim 16, wherein said first and second article orientations of each one of said plurality of articles comprise a yaw orientation, said yaw orientation of said second article orientation being provided about 90 degrees from said yaw orientation of said first article orientation.

18. An apparatus for changing the orientation of an article, comprising:

a rotational axis;

a first article location whereat the article has a first article orientation and whereat the article has a first direction of travel also defined by a vector;

a second article location whereat the article has a second article orientation and whereat the article has a second direction of travel also defined by said vector;

a hub adapted to rotate about said rotational axis, said rotational axis passing through said hub;

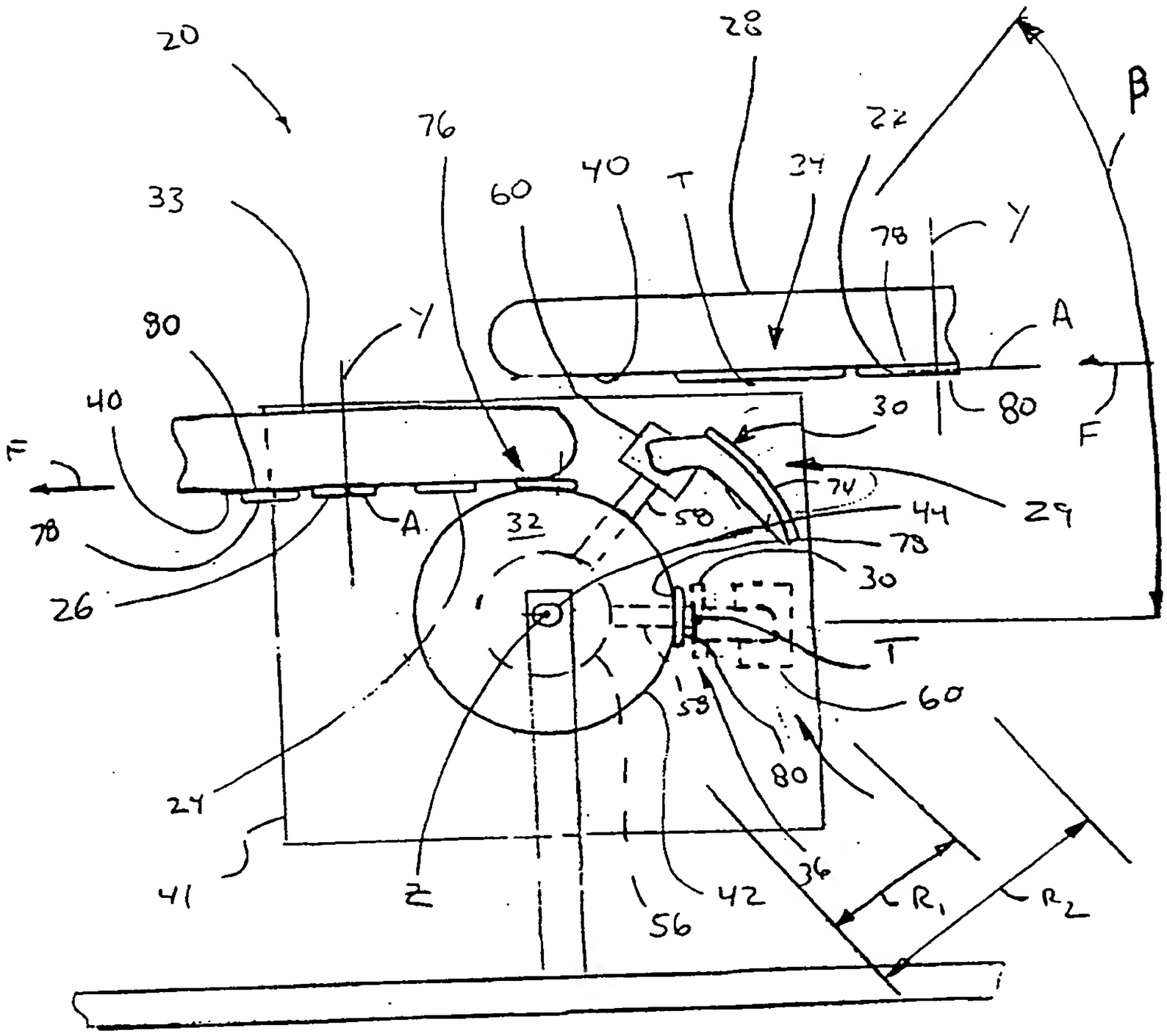
an arm connected to and extending radially outwardly from said hub;

a platform fixedly attached to said arm and adapted to receive the article adjacent said first article location and to discharge the article at said second article location; and

said platform adapted to rotate about said rotational axis to move from said first article location to said second article location.

19. The apparatus of claim 18, wherein said first and second article orientations of the article comprise a yaw orientation, said yaw orientation of said second article orientation being rotated about 90 from degrees from said yaw orientation of said first article orientation.

20. The apparatus of claim 19, wherein said first and second article orientations of the article further comprising a roll orientation, said roll orientation of said second article orientation being rotated about 90 degrees from said roll orientation of said first article orientation.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76
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40
T
34
22
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Y
β
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A
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30
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F
F
74
44
29
78
A
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30
26
T
60
59
80
24
41
Z
42
36
56
R1
R2

FIG 1

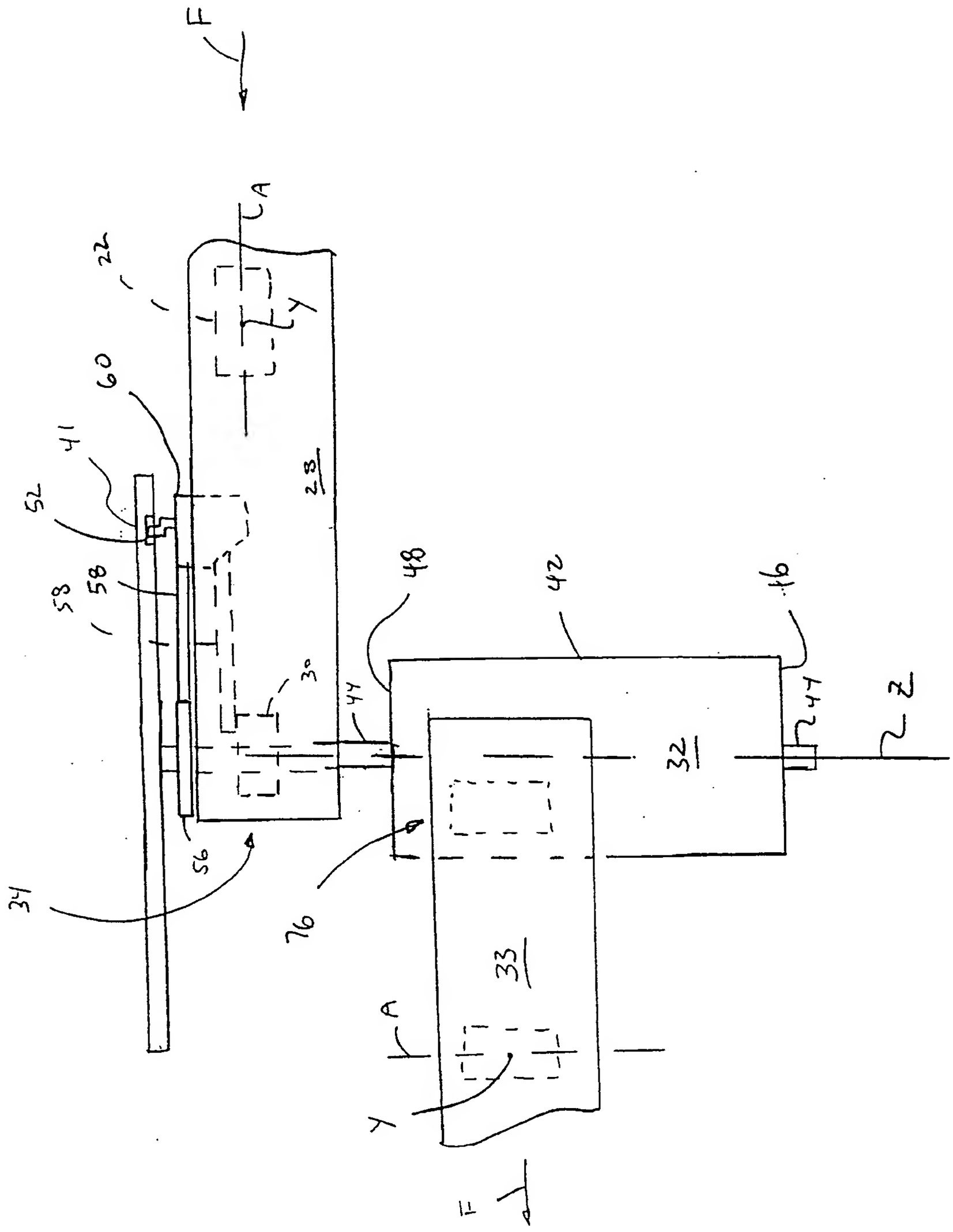


FIG. 2

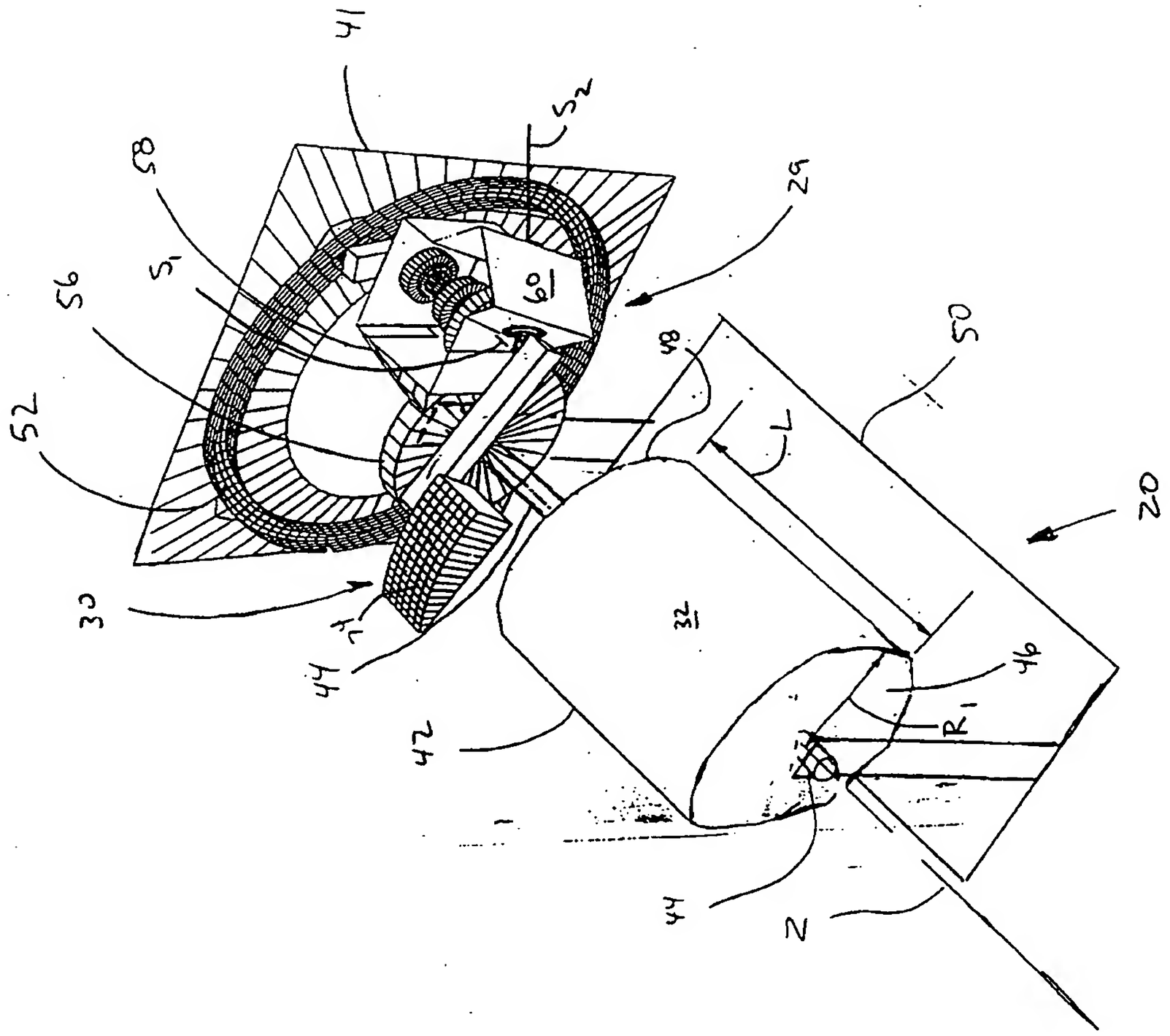


FIG. 3

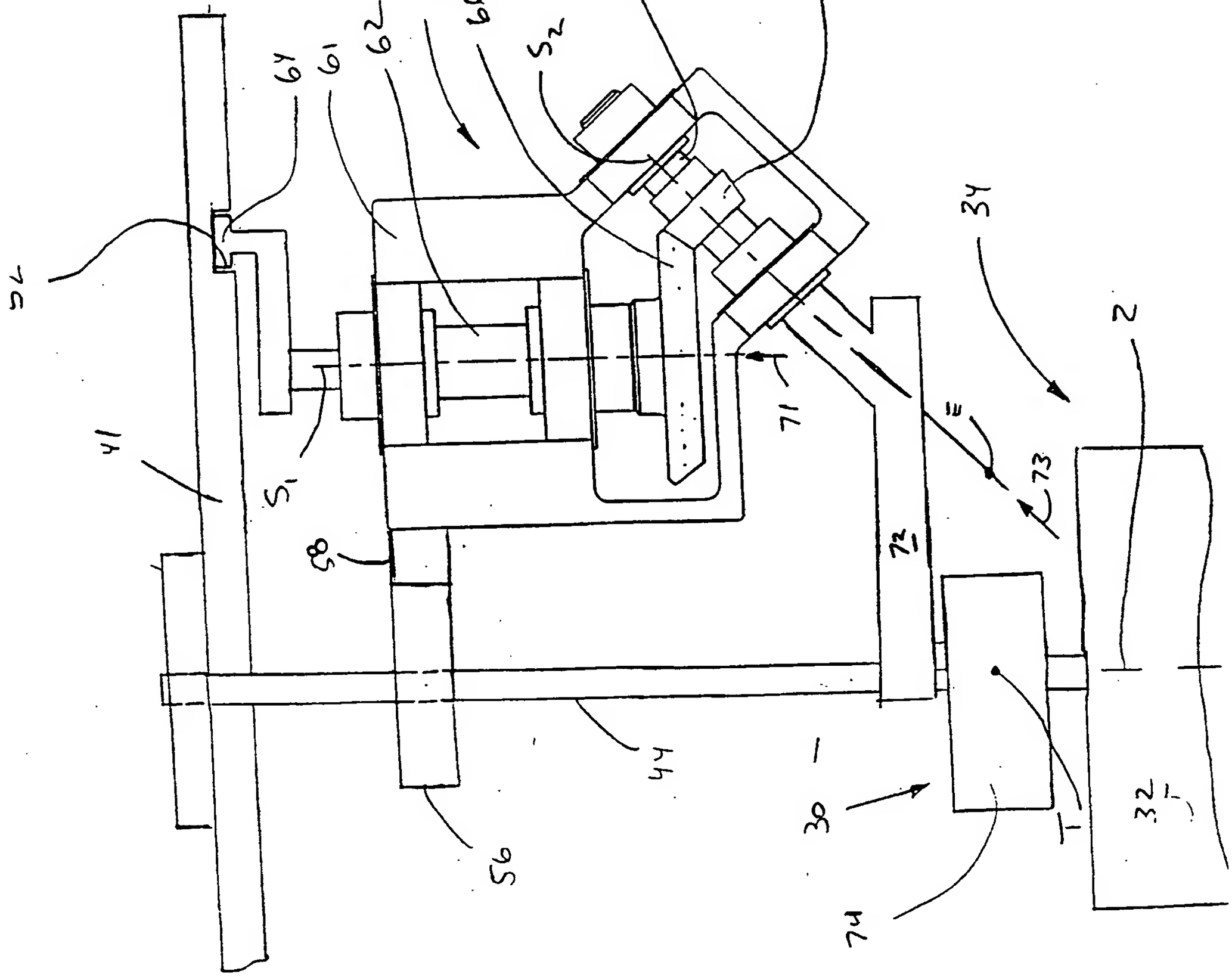


FIG 4

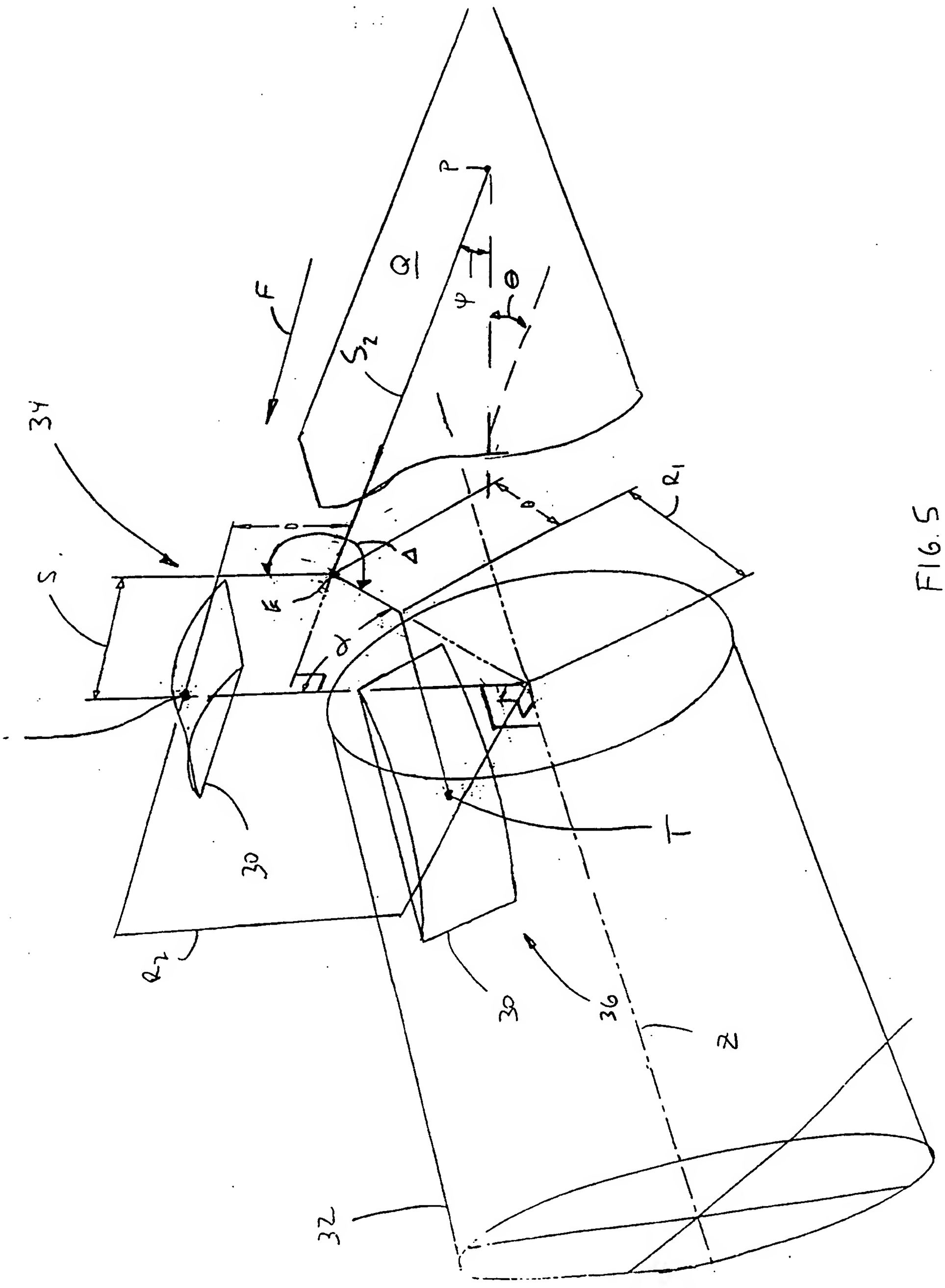


FIG. 5

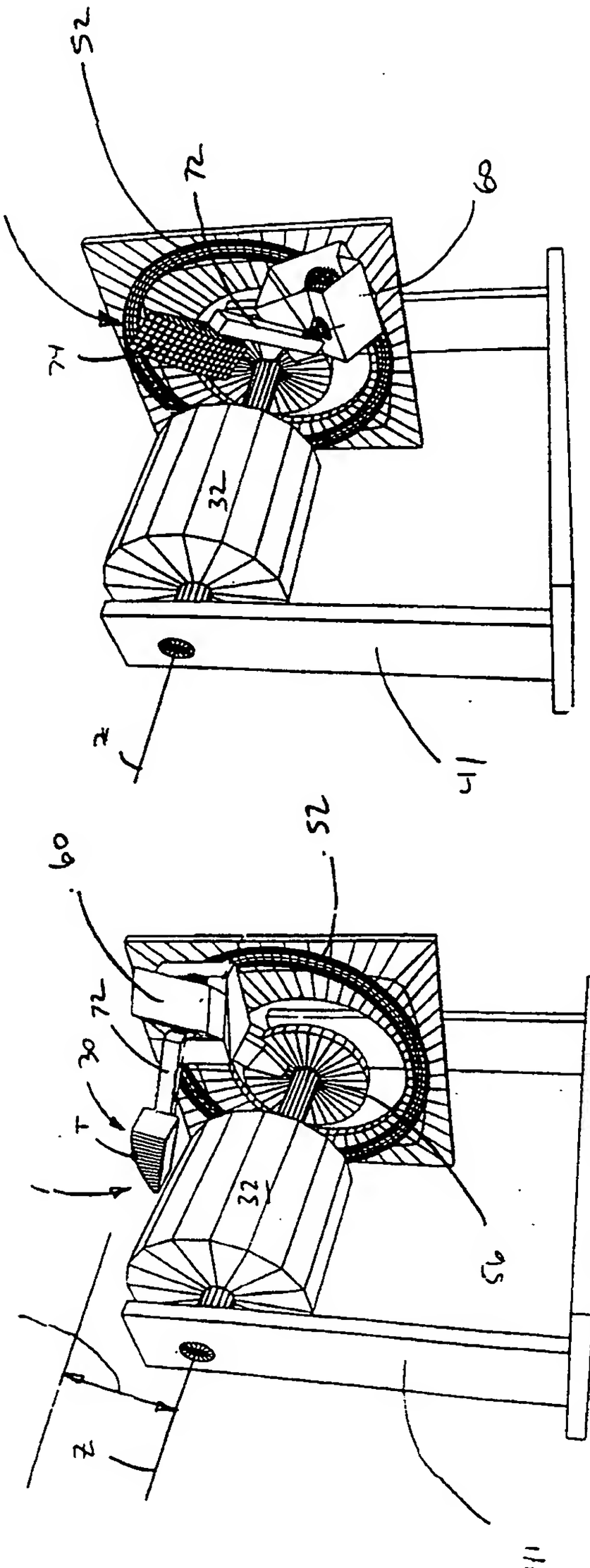


FIG. 6B

FIG. 6A

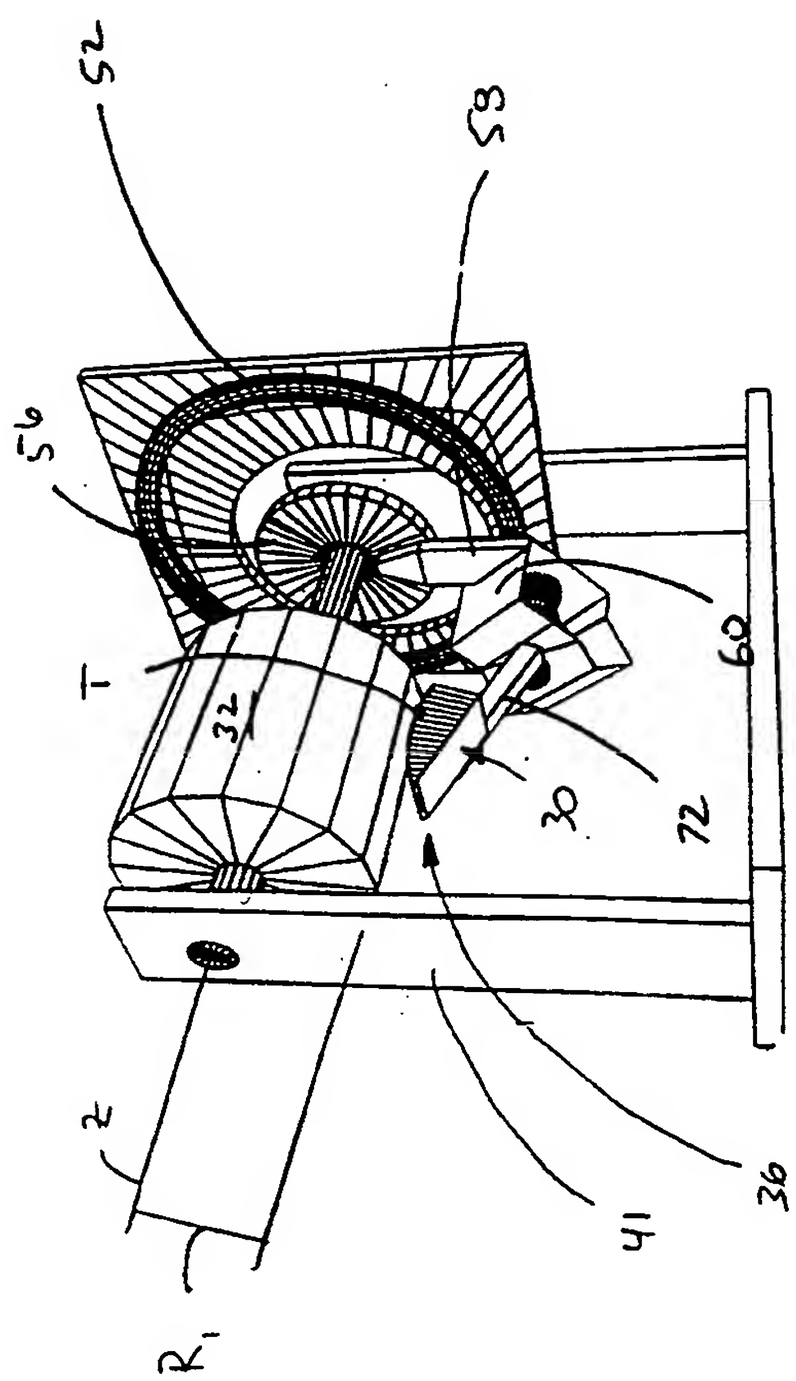


FIG. 6C

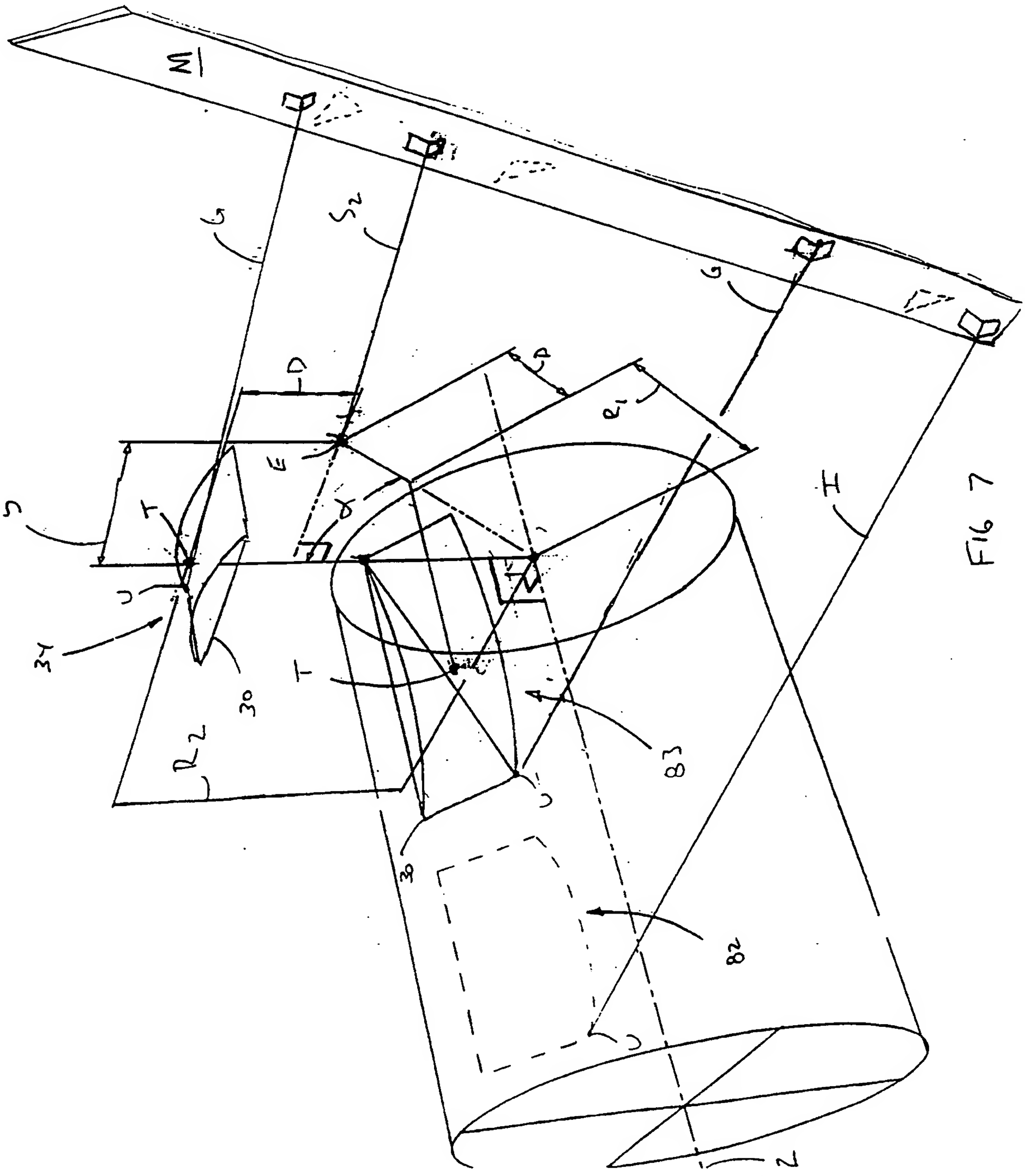
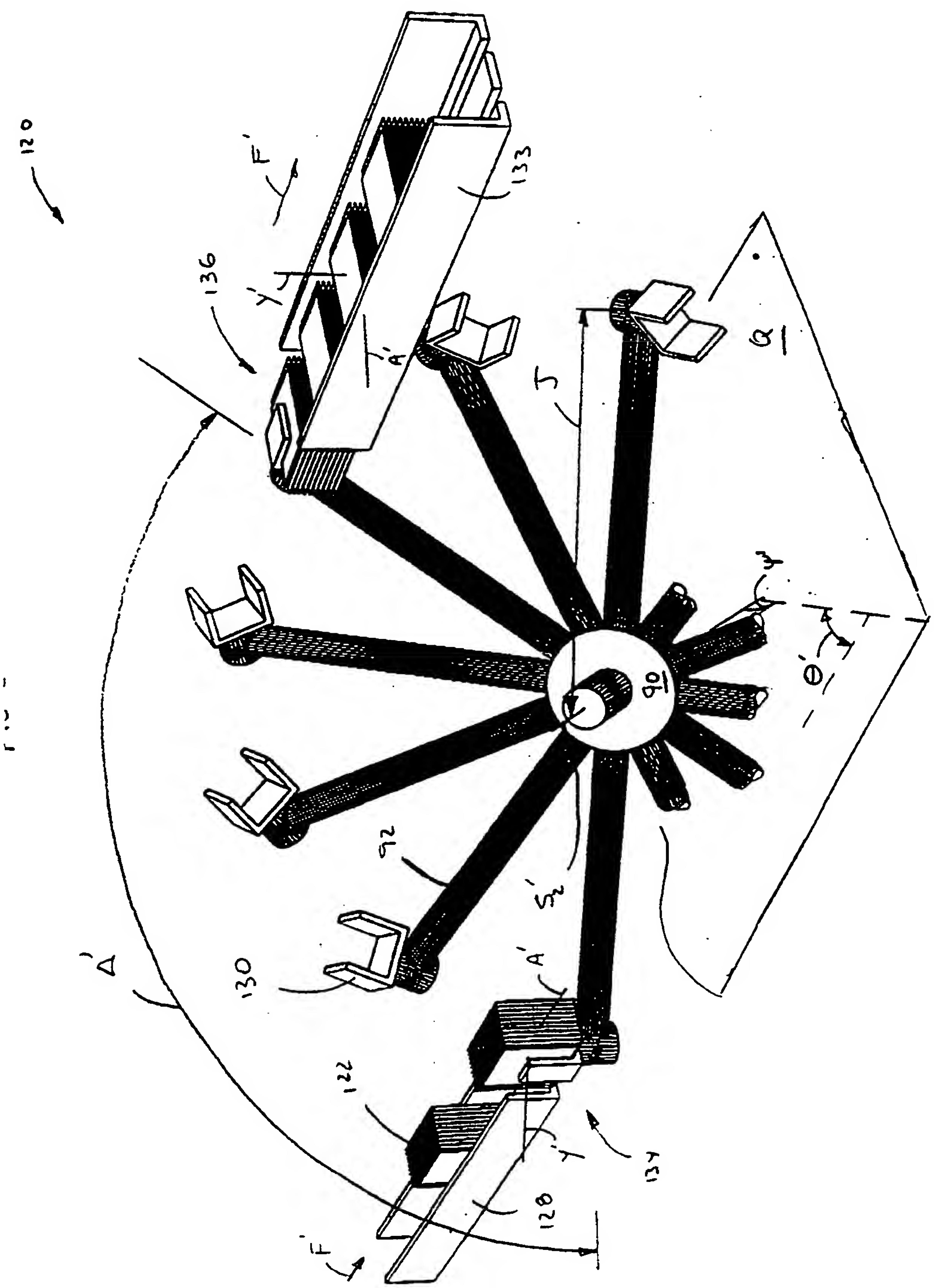


FIG 7


120
F'
136
Y'
A'
133
J
Q
ψ
θ'
90
92
S2'
A'
130
Δ'
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134
T'
128
F'

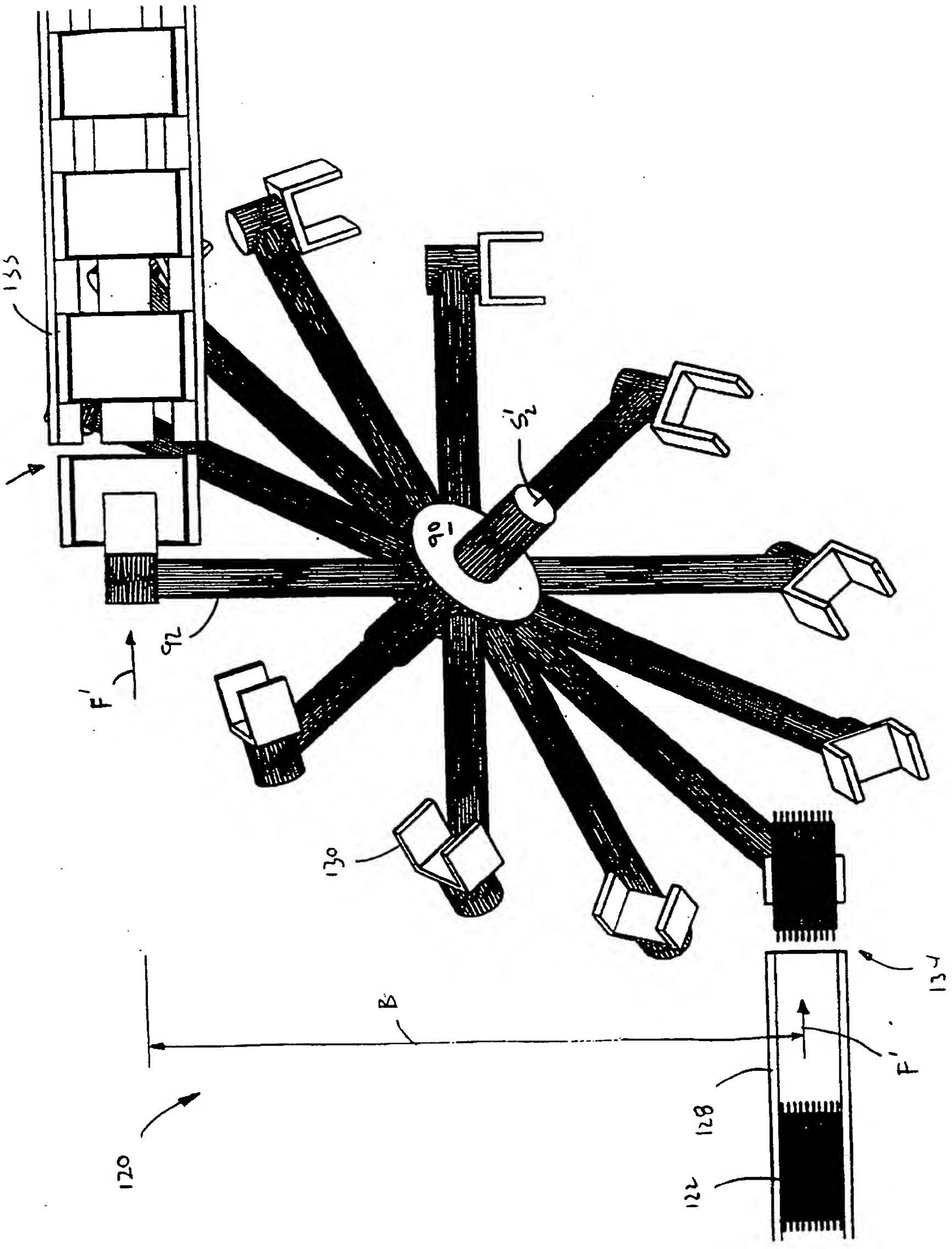

FIG. 9

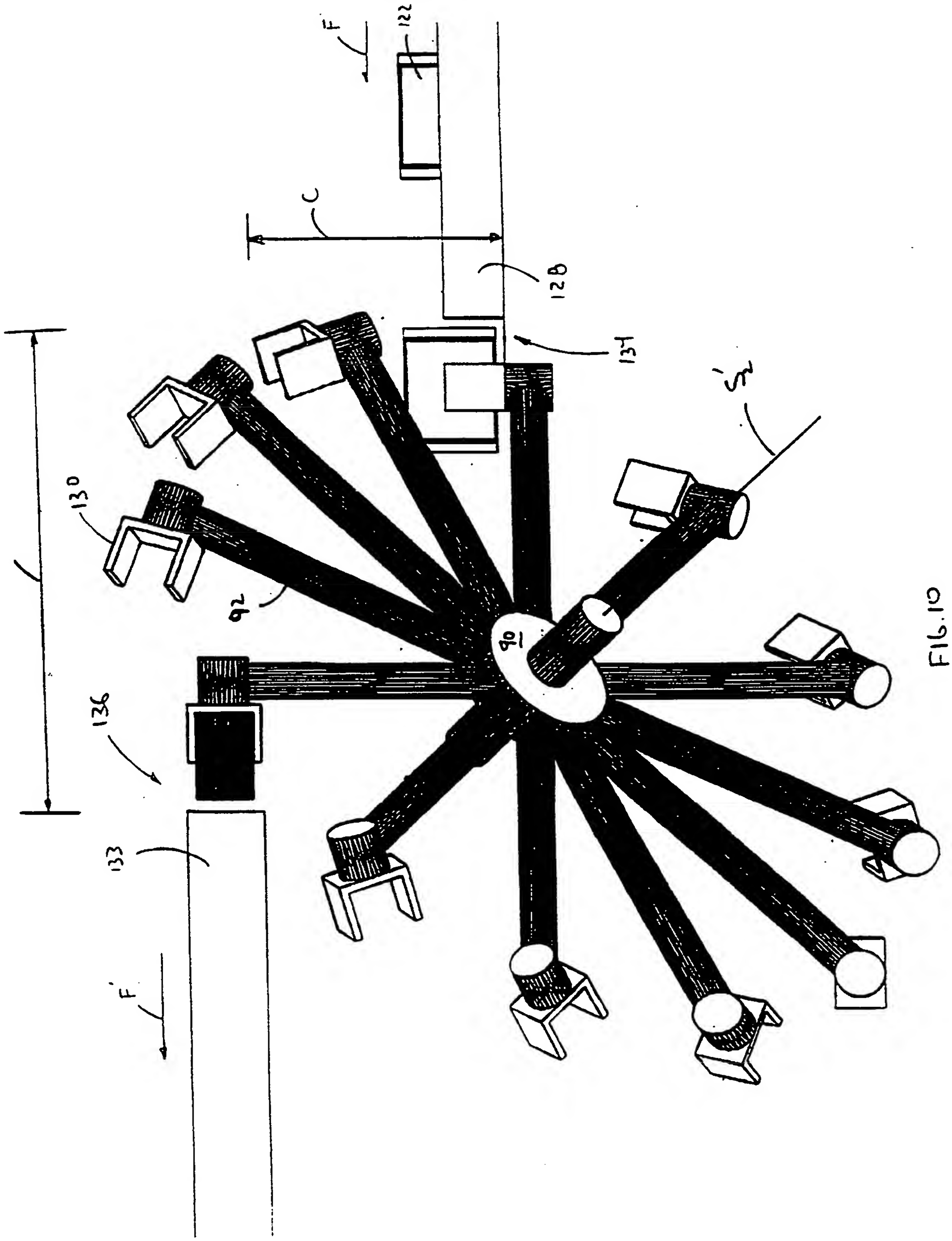

FIG. 10

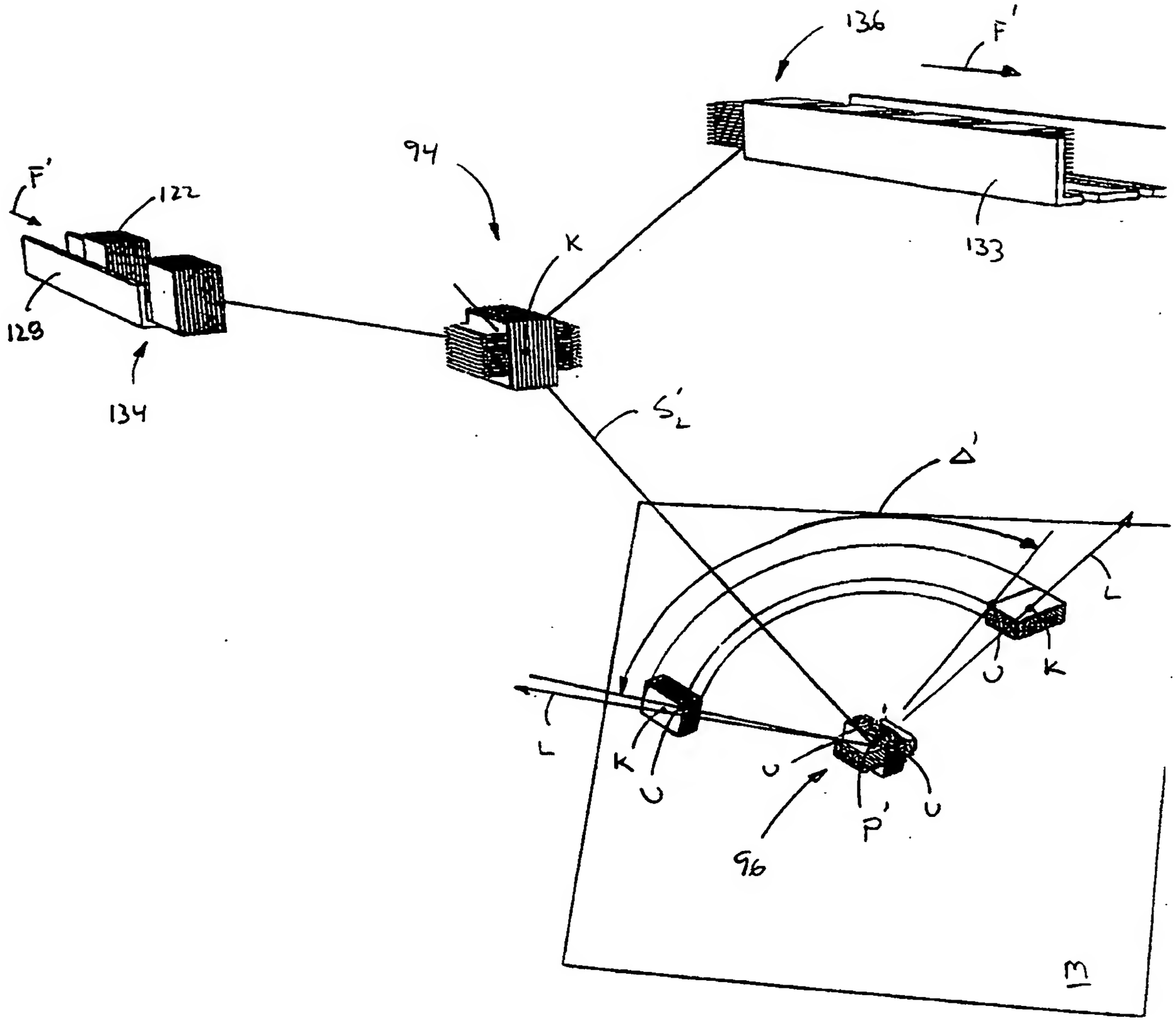

FIG 11

INTERNATIONAL SEARCH REPORT

Int ational Application No
PCT/US 99/15013

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B65G47/84 B65G29/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B65G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 787 667 A (AZIONARIA COSTRUZIONI) 6 August 1997 (1997-08-06) column 1, line 40 -column 1, line 57; figures	1,14,18
A	US 4 767 487 A (TOMSOVIC JR JAMES E) 30 August 1988 (1988-08-30) column 2, line 59 -column 3, line 11; figures	1,14,18
A	EP 0 439 897 A (JOA CURT G INC) 7 August 1991 (1991-08-07) claim 1; figures	1,14,18
X	EP 0 709 317 A (BAUMER SRL) 1 May 1996 (1996-05-01)	18
A	page 3, column 3, line 22 -page 4, column 5, line 27; figure 2	1,14

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 October 1999	29/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Ostyn, T

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INTERNATIONAL SEARCH REPORT

Inte ational Application No
PCT/US 99/15013

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

In' ıtional Application No
PCT/US 99/15013

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